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BASIC-ABSTRACT:

The printer control section (10) includes a microcomputer (20 (21) linked with ROM (23), RAM (24) and input/output port (25) by a data bus (21a). A programmable serial interface (22) connects with an external input device through connectors (11a,11b). The time constants table which associates the printing time with **print head** temperature and with the output voltage of the power supply battery (15). A voltage detector (15a) signals the battery output voltage to the CPU through an **A-D converter** (28). A **temperature sensor** (6a), similarly, signals to the CPU, the **print head** temperature.

ADVANTAGE - Optimum print quality is achieved irrespective of variations in battery voltage and print head temperature.

is a time
constants table which indicates a printing time corresponding to said thermal
print head temperature and power supply output voltage; wherein the print head
is energised in a predetermined period corresponding to said printing time for
each dot-line.

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Basic Abstract Text - ABTX (1):

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with ROM (23), RAM (24) and input/output port (25) by a data bus (21a). A
programmable serial interface (22) connects with an external input device
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printing time with **print head** temperature and with the output voltage of the
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(54) Thermal print head printing control apparatus.

(57) A thermal print head printing control apparatus monitors the thermal print head temperature and the power supply voltage, looks up an optimum printing time in a time constants table corresponding to the relationship between the temperature and the voltage and printing is performed in accordance with this printing time. This arrangement prevents the printing from becoming too dark as a result of the thermal print head heating up after extended periods of continuous use, and it also stops blurring; also, when the temperature drops the print does not become lighter. Therefore, a constant print density is maintained, providing best quality printing.

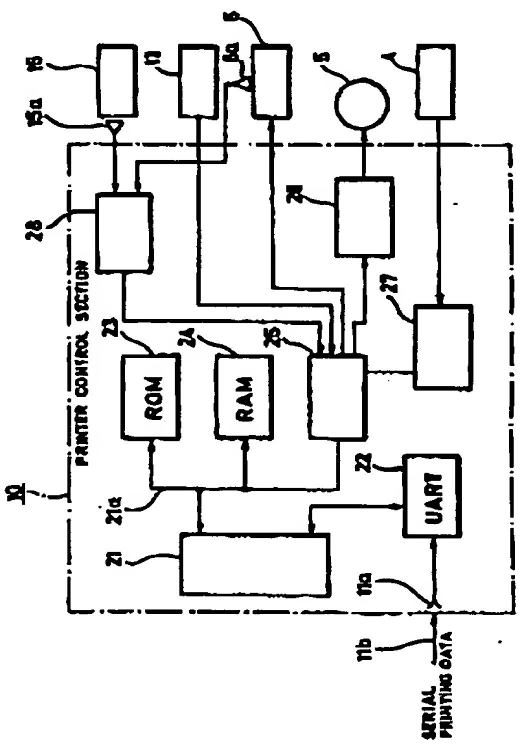

FIG.1

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of the printing operation and what they become in the course of the printing operation. The result is the occurrence of such problems as uneven and blurry printing of information on the print medium.

SUMMARY OF THE INVENTION

In view of the foregoing problems, an object of the present invention is to provide a thermal print head temperature control apparatus which enables a constant print density to be obtained at all times by performing printing in accordance with the current temperature of the thermal print head and the current power supply voltage value.

This object of the present invention is attained by storing in the printer control section which controls the thermal print head and the like, a time constants table which shows the optimum printing time corresponding to the supply voltage, i.e. the voltage application time for the heat and print medium is to be subjected to at the thermal print head, configured so that the said printer control section looks up the application time in the time constants table corresponding to the temperature as obtained from a thermal print head temperature detecting means and the voltage as obtained from a power supply voltage detecting means, arranged so that the thermal print head performs the printing in accordance with the said time.

The embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of a printer control circuit which includes a thermal print head printing control apparatus according to one embodiment of the present invention;

Figure 2 is a drawing illustrating a table of time constants for thermal print head voltage application showing the printing times corresponding to the thermal print head temperature and power supply voltage, the table being stored in the ROM shown in Figure 1;

Figure 3 is a circuit diagram illustrating one specific circuit of the thermal print head of Figure 1;

Figure 4 is a flow chart showing the control process of the microcomputer shown in Figure 1;

Figure 5 is a sectional view illustrating the construction of an ordinary portable thermal label printer.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The block diagram of Figure 1 illustrates the electrical configuration of the portable thermal label printer shown in Figure 5. In Figure 1, the optoelectronic sensor 4, the motor 5, the thermal print head 6, the printer control section 10, the connectors 11a and 11b and the switch 13 correspond to the parts in Figure 5 denoted by the same numbers. The construction will now be explained in detail with reference to Figure 1.

The printer control section 10 comprises a CPU in the form of a microcomputer 21, to which is connected, a programmable serial interface such as a UART 22, for example, and a bus 21a for transferring data between a ROM memory 23, a RAM memory 25 and an I/O port 25.

The UART 22 is connected to the external input device 12 shown in Figure 5 by means of the connectors 11a and 11b. Printing data stored in the external input device 12, that is, the data to be printed on the label B on the label separating sheet A by the thermal print head 6, is input and sent to the microcomputer 21 in serial form. In the ROM 23, which is connected via the bus 21a to the microcomputer 21, is permanently stored the microcomputer 21 control program and a character generator for generating dot pattern data in accordance with what is to be printed, and the thermal print head application time constants table - (hereinafter referred to simply as "table") shown in Figure 1 and which is a characterizing feature of the present invention.

The RAM 24, connected like the ROM 23 to the bus 21a, is for temporary storage of the above printing dot pattern data. The I/O port 25, also connected to the bus 21a, is for interfacing with the various mechanisms shown in Figure 1 (Figure 4 in the Japanese. Translator) (for example, the motor 14).

When the switch 13 shown in Figure 1 is operated, a switch (This may be an error for "print." Translator) start (print start) signal is input to the I/O port 25, and in accordance with this start signal, print operation start information is sent to the microcomputer 21. In order to start the motor 5 when the printing operation is to be commenced in accordance with the signal from the microcomputer 21, a drive signal is applied to a DC motor control circuit 28 and print dot pattern data and a strobe signal and the like are output to the thermal print head 6.

When the optoelectronic sensor 4 detects the mark on the label separating strip A, a mark detection signal is output from the mark detection circuit 27 to the I/O port 25, and when the I/O port 25 outputs that information to the microcomputer 21 the microcomputer 21 stops the operation of the thermal print head 6 and the motor 5.

Figure 3 shows details of the thermal print head 6. The thermal print head 6 is provided with heating element resistors R_1 -R_m which heat up in dot units corresponding to the print dot pattern data that is input for carrying out the printing. In the drawing, 31 denotes a shift register comprised of flip-flop circuits provided corresponding to the number of dots, for example. In accordance with a clock signal CLK input from the I/O port 25 shown in Figure 1, printing pattern data signals DI are input serially to the shift register 31 to accumulate one line of print pattern data. The numeral 32 denotes a latch circuit for latching the one line of print pattern data in the shift register 31 when a latch signal LAT is input from the I/O port 25.

C_1 -C_m are heating element drive segments provided to correspond with the number of dots in one line. The heating element drive segments C_1 - C_m have corresponding gate elements G_1 -G_m (C_1 - C_m in the Japanese. Translator), and for the driving by these elements, transistors T_{r1} -T_{rm} are provided connected in series with the heating element resistors R_1 -R_m between a power supply source E and ground. As a result, with respect to the heating element drive segments C_1 -C_m, when the strobe signal STR is input, gate elements G_1 -G_m open, and with respect to dot data input from the latch circuit 32 that is High (i.e., at the printing level) at this time, the output side of the gate elements G_1 - G_m goes High and this High signal is applied to the base of the corresponding transistor T_{r1} -T_{rm}, as a result of which current flows in the heating element resistors R_1 -R_m. The heat produced by this current flow results in one line of dots being printed on the label B at the thermal print head 6 shown in Figure 5.

When the thermal print head 6 is thus operated to print continuously, heat builds up in the print head so that in the latter part of the printing the temperature becomes high. With this embodiment of the present invention, as shown in Figure 1, a temperature detector (temperature detection means) such as a thermistor or the like is provided in the vicinity of the thermal print head 6. When the temperature in the label printing state becomes low, regarded on a single dot basis, the print becomes lighter than expected, while when the temperature is high, the print becomes darker. Therefore, when printing a bar code, for example, when the temperature is low the bars become finer while at high temperatures the bars become thicker and blurry. In order to improve this, the amount of time the print head uses to produce the print on the label is made variable in accordance with the temperature. That is, when the temperature of the print head is low the printing time is made longer than usual, and it is made shorter when the temperature is high.

Change in the power supply voltage is another possible factor which may cause a change in the printing state. In addition to the above control of printing time according to temperature, higher quality print can be obtained by means of a configuration whereby the printing time is also controlled in accordance with the power supply voltage value.

To realize this, in this embodiment, as shown in Figure 1, a voltage detector 15a (voltage detection means) is provided to detect the output voltage of the printer battery 15. The analog outputs of the temperature sensor .6a and the voltage detector 15a are input to the A/D converter 28 shown in Figure 1 where the analog temperature and voltage values are converted to digital form and output to the I/O port 25.

As explained in the foregoing, a table of printing times corresponding to the temperature of the thermal print head 6 and the output voltage of the battery 15 is stored in the ROM 23 of the printer control section 10 shown in Figure 1. Each square of the table displays in a specific unit the optimum printing time for each of the above current temperatures and current power supply voltages. For example, X indicates the printing time when temperature and supply voltage are at standard levels. Thus, when the temperature is a very high C + 3_m and the supply voltage a very high V + 3_a, the corresponding time X_1 is the shortest printing time in the table. On the other hand, when the temperature is a very low (The text has "high." Translator) C - 3_m and the supply voltage a very low V - 3_a, the corresponding time X_2 is the longest printing time in the table. Therefore, if for each printing by the thermal print head 6 reference is made to the table of Figure 2 that indicates the print head voltage application time constants stored in the ROM 23 and the printing is performed in accordance with the indicated printing time, it is possible to constantly obtain optimum printing.

The operation of the printer control section of Figure 1 with the thermal print head which prints thus will now be explained with reference to the flow chart of Figure 4.

At the start of the operation (step 101), the microcomputer 21 initializes the RAM 24, I/O port 25 and the registers in the microcomputer 21 (step 102). In the initialization, the printer control section 10 inputs the data to be printed from the external input device 12 shown in Figure 5. This print data is input to the microcomputer 21 via the UART 22

and is temporarily stored in the RAM 24 as parallel data (step 103). As the print data is in code form, it has to be converted to print dot image pattern data. For this, the microcomputer 21 refers to the character generator provided in the ROM 23 to convert the print data stored in the RAM 24 to print pattern data, which is then stored back in the RAM 24 (step 104). When the print data input from the external input device 12 has been converted to print pattern data, the printer control section 10 is readied for producing labels B.

The production of the labels B is started by operating switch 13. When switch 13 is pressed a start signal from the switch 13 is input to the I/O port 25 and then output to the microcomputer 21 via the bus 21a. At this point the microcomputer 21 is waiting for the switch-on state of the switch (step 105), and when it is detected that the start signal has been input the procedure moves on to step 106 at which it is checked whether a label B has been transported to the specified position, i.e. the printing start position. When the label B comes to the printing start position the optoelectronic sensor 4 detects the mark on the label separating sheet A and a mark detection signal is output to the I/O port 25 by the mark detection circuit 27. Until the mark is detected the microcomputer 21 continues to output to the I/O port 25 a motor drive signal to drive the motor 5 for transporting the label separating sheet A. When this motor drive signal from the I/O port 25 is applied to the motor drive control circuit 26, the motor 5 is energized for one step. This energization is repeated a number of times (step 107) until the said mark is detected, whereupon the procedure advances along the Yes line in step 106.

In the next step, step 108, the microcomputer 21 reads out the printing pattern data stored in the RAM 24 in order to send one line of printing pattern data to the thermal print head 6, and outputs the data to the thermal print head 6. The clock signal CLK and the printing pattern data signals DI are input to the thermal print head 6 via the I/O port 25, and the printing pattern data are read into the shift register 31 a dot at a time in accordance with the clock signals CLK (step 108). Following this, the latch signal LAT is input to the thermal print head 6 from the I/O port 25. By means of the latch signal LAT, the printing dot pattern data entered in the shift register 31 is fetched, and latched in the latch circuit 32 (step 109) ("Pattern S109" in the Japanese. Translator). Next, the temperature CX of the thermal print head 6 as detected by the temperature detector 6a (step 110) is read by the microcomputer 21 via the I/O port 25 and the A/D converter 28, and the output voltage VX of the battery 15 is detected by the voltage detector 15a (step 111). The detected temperature CX and voltage VX are input to the A/D converter 28 where they undergo conversion from analog to digital values. The converted temperature CX and voltage VX are output to the microcomputer 21 via the I/O port 25. The microcomputer 21 searches the constant table (Figure 6) stored in the ROM 23 for the temperature CX and the voltage VX (step 112). The value of the intersection of the retrieved values, i.e. the appropriate printing time TX value is set as the application time T in the microcomputer 21 (step 113).

At this point it is determined (in step 114) by the microcomputer 21 whether the conditions are right for the thermal print head 6 to print to the label separating sheet A, that is, whether it is the right time for the heating. If it is, the procedure moves to step 115. The print head heating is performed in step 115 by a strobe signal STR the microcomputer 21 outputs to the thermal print head 6 via the I/O port 25.

The strobe signal STR is applied uniformly to one of the input terminals of each of the gate elements G_1-G_m of the heating element drive segments C_1 -C_m, as shown in Figure 3. When the strobe signal STR thus applied is High, as the print dot pattern data is being input in dot units from the latch circuit 32 to the other input terminal of the gate elements G_1 -G_m, a High signal appears on the output side only of those of the gate elements G_1 -G_m which have a High signal applied to both input terminals, and the said High signal output signal is applied to the base of the corresponding transistors T_{r1} -T_{rm}. Therefore, the transistors T_{r1} -T_{rm} to the base of which a High signal is applied are turned on, and the corresponding element resistors R_1 -R_m heat up. This heat results in one dot line being printed on a label B which has been transported to the thermal print head 6 position (Figure 5). This printing is carried out in the interval in which the strobe signal STR is being sent from the I/O port 25 to the thermal print head 6. After a set time has elapsed from the output to the I/O port 25 of the strobe signal STR by the microcomputer 21, the application time T value set as described in the above is decremented by one (step 116). Following this, it is determined whether T has become zero (step 117). If T does not equal zero, the strobe signal STR continues to be output. After a further fixed time has elapsed, the value of T is decremented by one.

Thus, if T = 32, after T has been decremented 32 times so that T = 0, in step 117 the procedure will advance along the Yes line to step 118 where the application of heat from the thermal print head 6 to the label separating sheet A is stopped. This is done by stopping the strobe signal STR which is being output from the microcomputer 21 to the thermal print head 6 via the I/O port 25. That is, the

signal at the STR terminal (Figure 3) goes Low, which turns of the operation of the transistors T_{r1} - T_{rm}, which shuts off the current that has been flowing up to that point in the heating element resistors R_1 -R_n to produce heat. Shutting ff the current ends one dot-line of printing by the thermal print head 6. At this point, it is determined whether the mark on the label separating sheet A has been detected by the optoelectronic sensor 4 (Figure 1). If the mark has been detected, the printing is ended (step 119) and the procedure ends (step 120). If the mark is not detected in step 119, the process branches off to the next step along the No line. In step 121, the second dot-line of the print dot-pattern data is stored in the shift register 31 in accordance with the clock signal CLK. In order to print the next line of dots, the microcomputer 21 outputs a motor drive signal to the motor drive control circuit 26 to advance the motor 5 by one step so as to transport the label separating sheet A by the amount of one dot-line (step 122). Following this, the procedure goes back to step 109 and the above sequence of operations is repeated.

Through the repetition of steps 109 to 122, a printing time corresponding to the temperature of the thermal print head 6 and the output voltage of the battery 15 is obtained by reference to the constants table (Figure 2) stored in the ROM 23, and by printing in accordance with this printing time, the print can be maintained at a constant density.

In the above embodiment the temperature of the thermal print head and the output voltage of the battery are detected for each line of dots printed. However, it may also be carried out at the end of each of a series of printing operation cycles; or, a length of time may be set in which the print density may be affected and the detection carried out after that time has elapsed and printing time altered in accordance with the printing time indicated in the constants table.

Key to Figure 1

I Serial printing data
II Printer control section
4 Optoelectronic sensor
5 Motor
6 Thermal print head
6a Temperature sensor
11a/b Connectors
13 Switch
14 Motor
15 Battery
15a Voltage detector
21 Microcomputer
25 I/O port
26 Motor control circuit
27 Mark detection circuit
28 A/D converter

Key to Figure 2

V Standard battery voltage
C Standard temperature

Key to Figure 3

i From I/O port
ii Thermal print head
31 Shift register
32 Latch circuit

Key to Figure 4

101 Start
102 Initialize
103 Input data & store in RAM
104 Convert to printing pattern data & store in RAM
105 Start printing
106 Mark detect
107 Transport
108 Store one dot-line in shift register
109 Latch
110 CX detect
111 VX detect
112 Refer to table, using VX and CX3
114 Heat time
115 Print head heating
118 Stop print head heating
119 Stop printing
120 End
121 Store next dot-line in shift register
122 Advance by amount of one dot-line

WORD LIST

1 main unit
2 label holder
3 label roll
4 optoelectronic sensor
5 motor
5 platen
6 thermal print head
6a temperature sensor
7 bending pin
9 roller
10 printer control section
11a/b connectors
12 external input device

13 switch
14a-d rollers
14 motor
15 battery
15a voltage detector
21 microcomputer
21a bus
22 UART
23 ROM
24 RAM
25 I/O port
26 motor control circuit
27 motor control circuit
28 A/D converter
31 shift register
32 latch circuit

Claims

A thermal print head printing control apparatus which has a temperature detecting means for detecting the temperature of a thermal print head which employs heat to print on a print medium; power supply voltage detecting means for detecting at least the output voltage of a power supply that applies a voltage to the thermal print head for the said heating; and a time constants table which indicates a printing time corresponding to said thermal print head temperature and power supply output voltage;
said time constants table being provided in a memory storage means of a printer control portion which controls the thermal print head and the transport of the said print medium;
whereby in the printing of the said print medium, the said printer control portion controls the printing so that printing is performed in accordance with a printing time based on the said thermal print head temperature and power supply voltage.

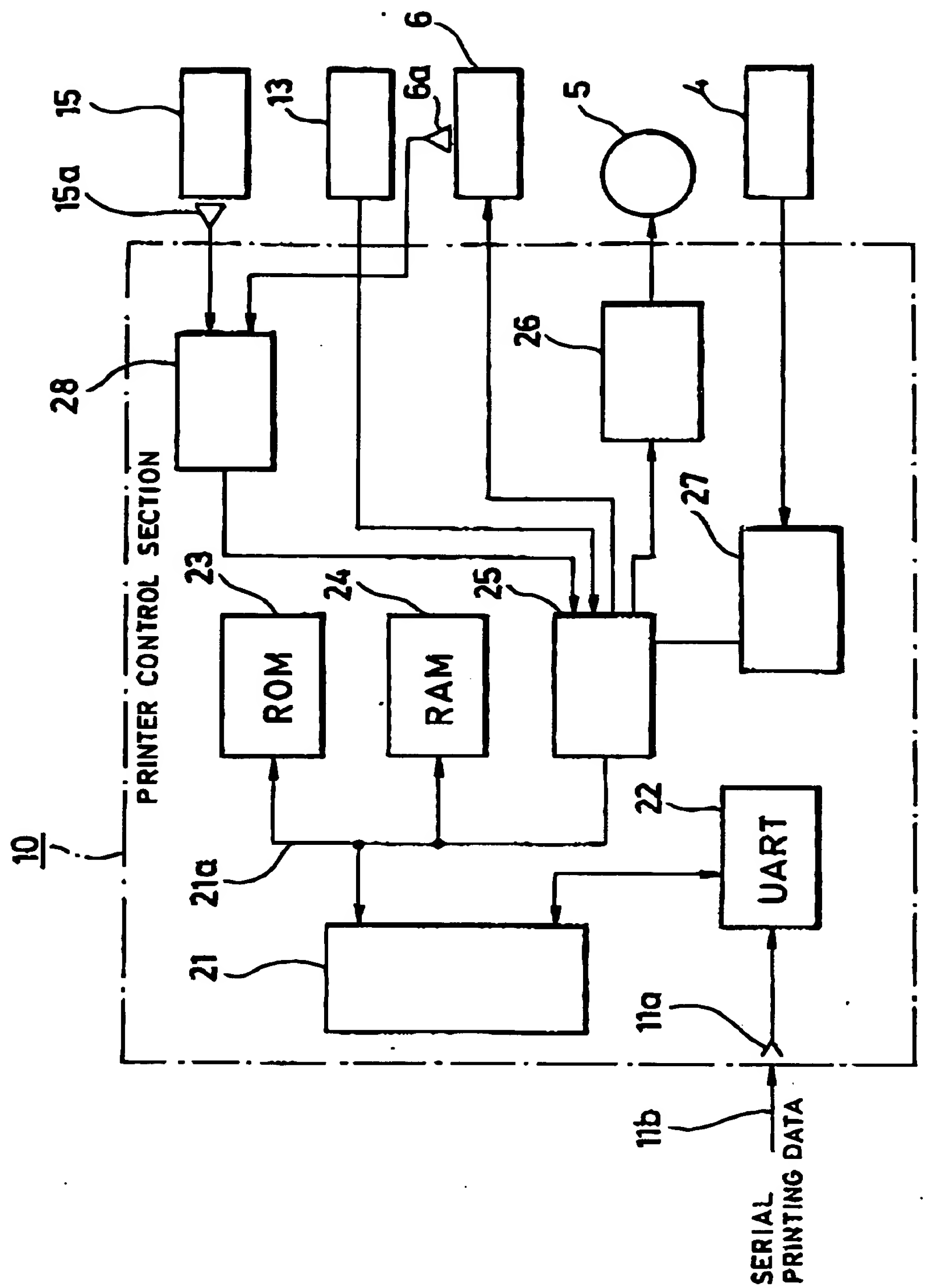
10
PRINTER CONTROL SECTION
15
15a
13
6a
6
5
4
28
26
27
23
24
25
ROM
RAM
22
UART
21a
21
11a
11b
SERIAL PRINTING DATA

FIG.1

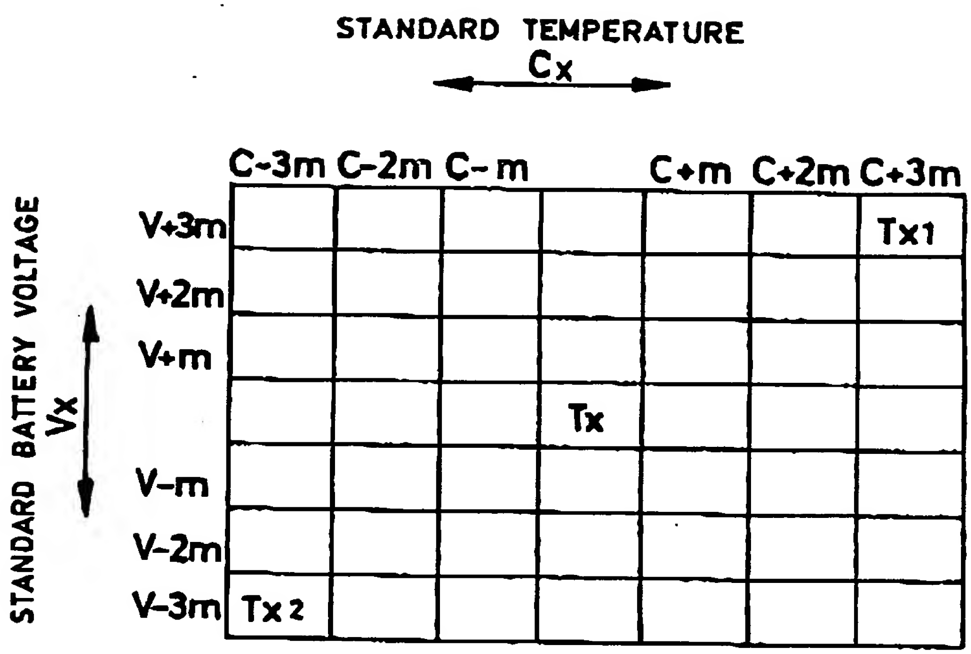
STANDARD TEMPERATURE
Cx
C-3m C-2m C-m C+m C+2m C+3m
STANDARD BATTERY VOLTAGE
Vx
V+3m
V+2m
V+m
V-m
V-2m
V-3m
Tx1
Tx
Tx2

FIG. 2

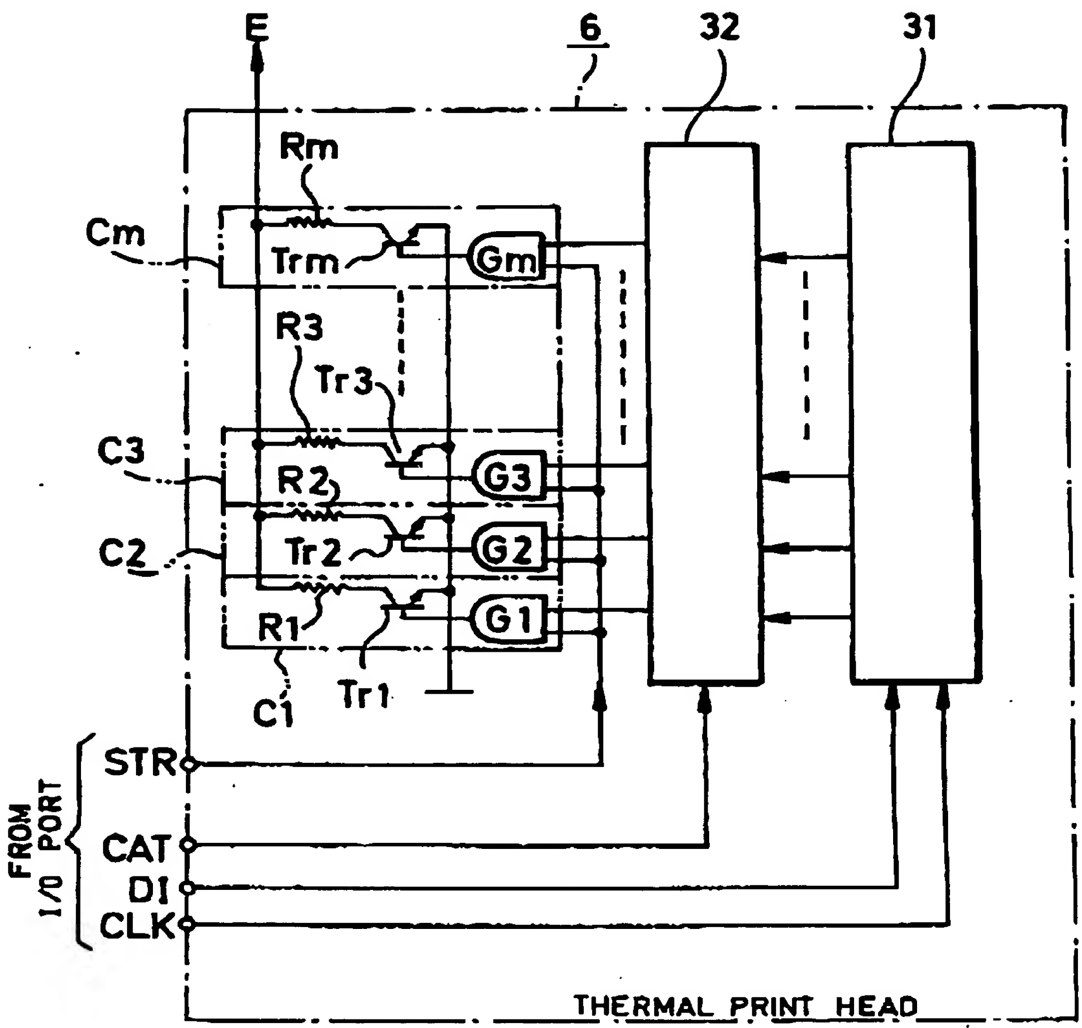
E
6
32
31
Rm
Cm
Trm
Gm
R3
Tr3
C3
R2
G3
C2
Tr2
G2
R1
G1
C1
Tr1
STR
FROM I/O PORT
CAT
DI
CLK
THERMAL PRINT HEAD

FIG. 3

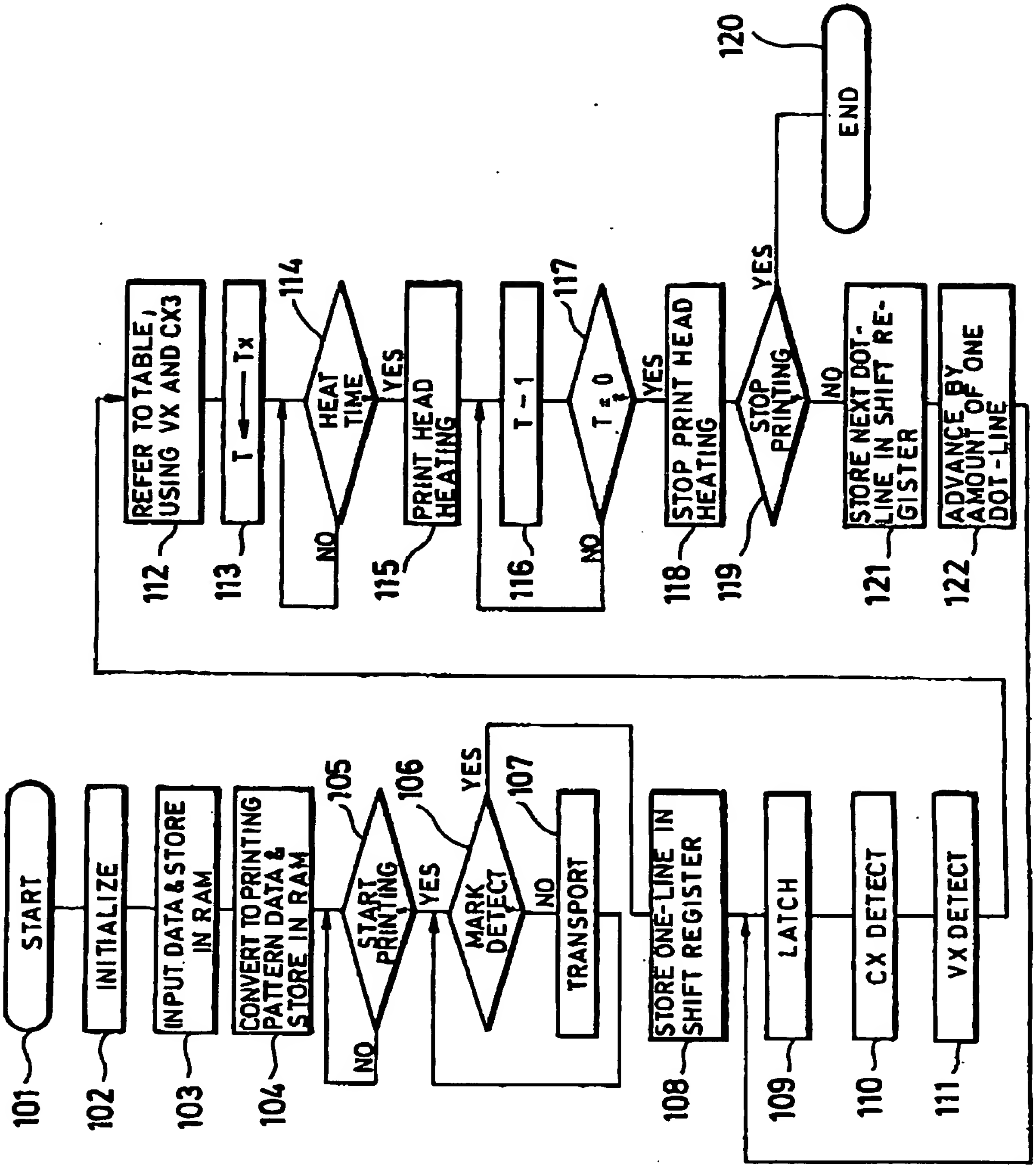
START
101
INITIALIZE
102
INPUT DATA & STORE IN RAM
103
CONVERT TO PRINTING PATTERN DATA & STORE IN RAM
104
START PRINTING
105
YES
NO
MARK DETECT
106
YES
NO
TRANSPORT
107
STORE ONE-LINE IN SHIFT REGISTER
108
LATCH
109
CX DETECT
110
VX DETECT
111
REFER TO TABLE, USING VX AND CX3
112
T ← Tx
113
HEAT TIME
114
YES
NO
PRINT HEAD HEATING
115
T - 1
116
T = 0
117
YES
NO
STOP PRINT HEAD HEATING
118
STOP PRINTING
119
YES
NO
END
120
STORE NEXT DOT-LINE IN SHIFT REGISTER
121
ADVANCE BY AMOUNT OF ONE DOT-LINE
122

FIG.4

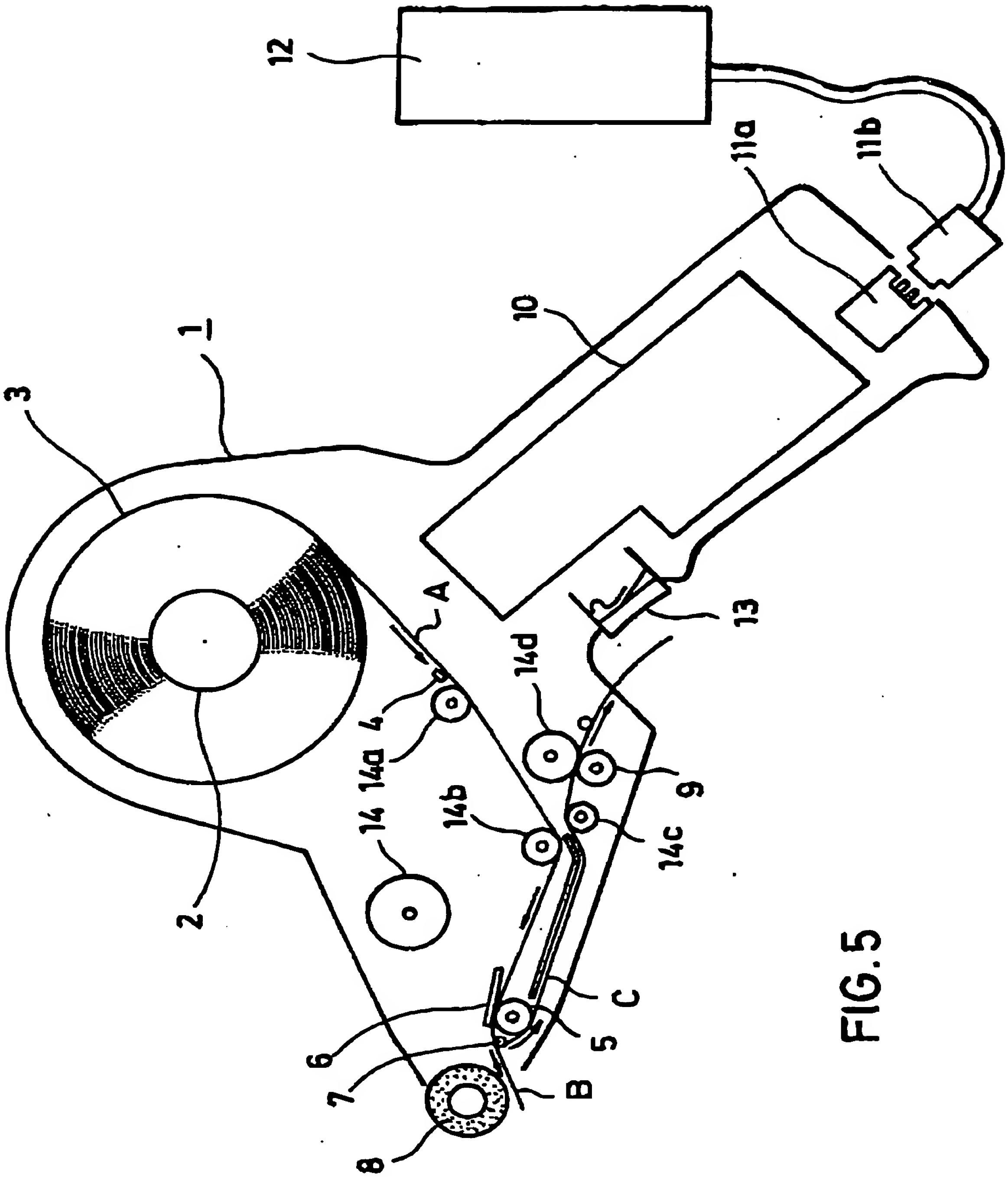

FIG.5